United States Department of Agriculture

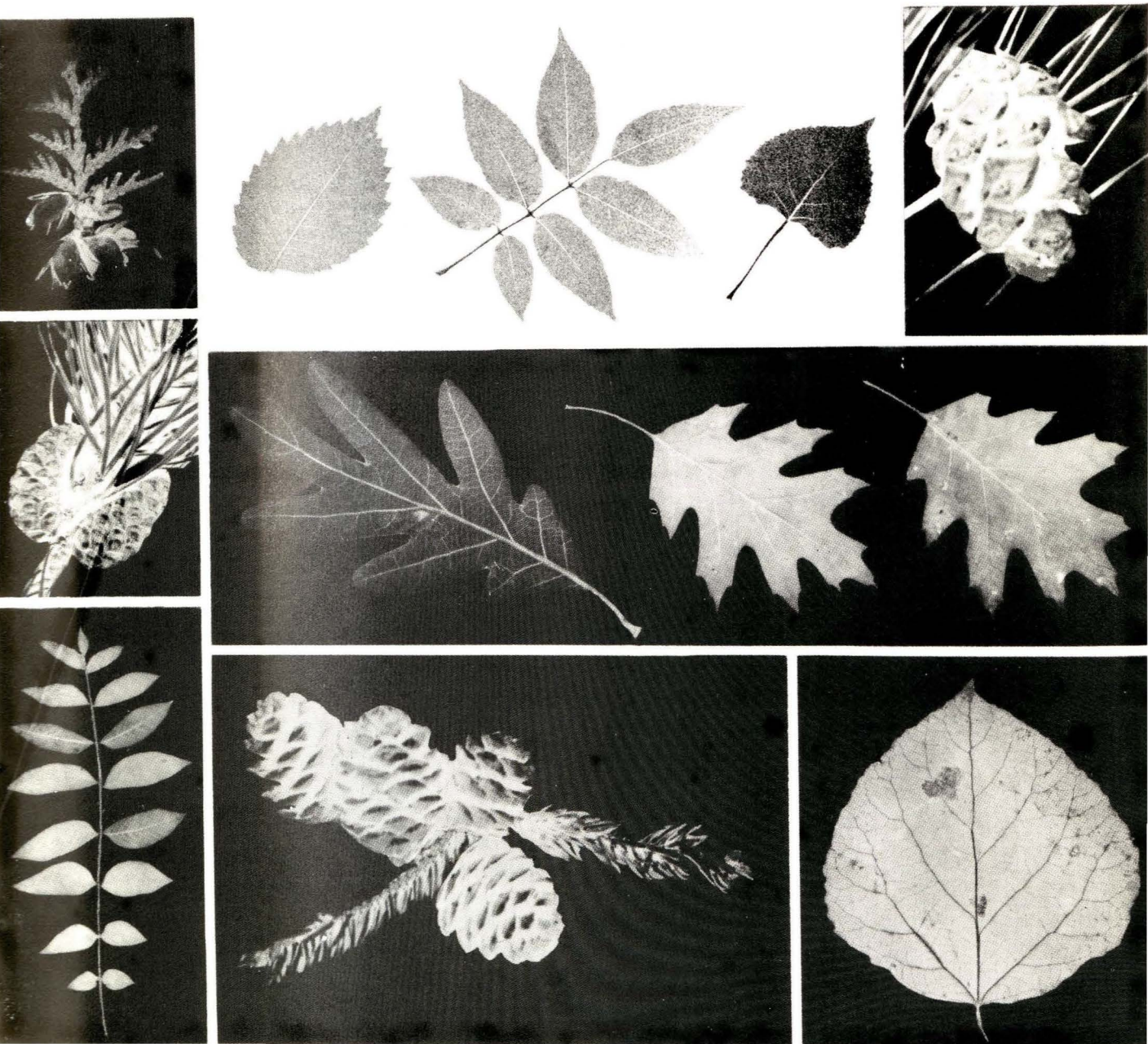
Forest Service

North Central Forest Experiment Station

General Technical Report **NC-98**

Manager's Handbook for Elm-Ash-Cottonwood in the North Central States

Charles C. Myers and Roland G. Buchman



North Central Forest Experiment Station
Forest Service—U.S. Department of Agriculture
1992 Folwell Avenue
St. Paul, Minnesota 55108
Manuscript approved for publication May 9, 1984
September 1984

FOREWORD

This is one of a series of manager's handbooks for important forest types in the North Central States. The purpose of this series is to present the resource manager with the latest and best information available on managing these types. Timber production is dealt with more than other forest values because it is usually a major management objective and more is generally known about it. However, ways to modify management practices to maintain or enhance other values are included where sound information is available.

The authors have, in certain instances, drawn freely on unpublished information provided by scientists and managers outside their specialty. They are also grateful to several technical reviewers in the region who made many helpful comments.

The handbooks have a similar format, highlighted by a "Key to Recommendations". Here the manager can find, in logical sequence, the management practices recommended for various stand conditions. These practices are based on research, experience, and a general silvical knowledge of the predominant tree species.

All stand conditions, of course, cannot be included in the handbook. Therefore, the manager must use technical skill and sound judgment in selecting the appropriate practice to achieve the desired objective. The manager should also apply new research findings as they become available so that the culture of these important types can be continually improved.

CONTENTS

	Page
Definition of Type	1
Silvical Highlights	1
Management Objectives	1
Key to Recommendations	2
Timber Management Considerations	2
Stand Size	2
Site Quality	3
Site—Species Relations	3
Controlling Stand Harvest	3
Mature Stands	3
Diverse Stands	4
Immature Stands	4
Understocked Stands	5
Controlling Stand Establishment	5
Controlling Composition	5
Artificial Regeneration	5
Damaging Agents	6
Flooding	6
Fire	6
Disease	6
Insects	6
Other Resourse Considerations	6
Wildlife	6
Water	6
Recreation and Esthetics	6
Appendix	8
Site Index Curves	8
Even-age Stocking Levels	10
Metric Conversion Factors	10
Common and Scientific Names of Plants and Animals	10
Pesticide Precautionary Statement	10
References	11

MANAGER'S HANDBOOK FOR ELM-ASH-COTTONWOOD IN THE NORTH CENTRAL STATES

Charles C. Myers, *Professor,*
Department of Forestry,
Southern Illinois University,
Carbondale, Illinois,
and **Roland G. Buchman,** *Biometrician,*
St. Paul, Minnesota

DEFINITION OF TYPE

Elm-ash-cottonwood (E-A-C), a forest type recognized by the Renewable Resources Evaluation Group of the U.S. Forest Service, is comprised of the following Society of American Foresters cover types (SAF number): black ash-American elm-red maple (39); silver maple-American elm (62); cottonwood (63); sugarberry-American elm-green ash (93); sycamore-sweetgum-American elm (94); and black willow (95). Many associated species are found in these moist site, bottomland hardwood stands.

A stand will be recognized as E-A-C if more than half of the basal area (or stem count if seedlings and saplings make up the whole stand) is composed of tree species named in the six associated SAF types.

SILVICAL HIGHLIGHTS

Elm-ash-cottonwood is found on alluvial soils along rivers and streams throughout the North Central States. The type is common on land subject to annual flooding and can survive flooding during as much as 50 percent of the growing season. A subclimax type, it follows pure cottonwood and willow stands. These pioneer species become established wherever sufficient light and moist bare soil are available. Cottonwood outgrows willow and becomes dominant forming two-storied stands, unless extended flooding during the growing season kills back the more susceptible cottonwood. Cottonwood and willow cannot regenerate under shade and are gradually replaced by more tolerant species including silver maple, American elm, green ash, sycamore, and river birch. In the southern part of the range sweetgum and hackberry are common.

To obtain natural reproduction of major species in the association, certain sites are required. Cottonwood, river birch, willow, and sycamore have light seed that can be borne for considerable distance by wind and water, but will remain viable for only a few days. These seeds require mineral soil exposed to direct sunlight for germination. Open sites with siltation from flooding are excellent for natural establishment.

American elm, green ash and silver maple seed can germinate on moist litter as well as on mineral soil. These species make best early growth in partial shade. They often regenerate profusely from either seed or vegetatively after cutting or disturbance. While Dutch elm disease has practically eliminated mature elms from the type, seedlings and saplings are abundant. Trees as young as 15 years produce seed.

As many as 50 species having some commercial importance are associated with the elm-ash-cottonwood type. Factors such as fire, cutting, flooding, insects, disease, and natural succession cause frequent rapid changes in species composition. Elm-ash-cottonwood is a pioneer to intermediate type that cannot be maintained without management or natural disturbance. Flooding and timber removal are important conditions for its establishment and continued existence.

MANAGEMENT OBJECTIVES

Production of high value sawtimber and veneer is the primary management objective. It is met primarily in the final harvest, which emphasizes sawtimber and veneer logs.

A secondary objective is the production of wood for paper, fuel, and other products. Intermediate thinnings may produce large quantities of material for these secondary products.

A tertiary objective is to provide for other uses of these valuable sites, including food and shelter for wildlife and waterfowl, watershed protection and erosion control, and a variety of recreation activities. Generally, these values are enhanced by timber harvesting and management. However, harvesting practices may require modifications should certain values—such as esthetics—predominate. Details on how to meet these management objectives are given throughout the text.

Regardless of the purpose of management, the primary vegetative, soil, and water resources must be protected. Site protection during timber harvest—especially erosion control—is needed in addition to protecting the timber from insects, disease, and fire. These protection guidelines are appropriate where management doesn't emphasize timber production.

KEY TO RECOMMENDATIONS

Recommendations are given for applying silvicultural practices appropriate for the specific conditions of a stand. These recommendations are based on the best management and silvicultural information currently available. They should be considered a guide and not a substitute for on-the-ground observations and management experience. All possible stand conditions cannot be described; the manager must select the practice best suited for the particular situation. Additional research is needed to improve management of this important type on very productive river bottom sites.

The key is based primarily on stand basal area, number of trees per acre, and site quality and tree diameter. Inventory practices for estimating these variables are well established and are not presented in detail in this handbook.

When using the key, start with the first pair of numbered statements and select the statement that best describes the stand to be managed. The selected statement will direct you either to another pair of numbered statements or to a management prescription for the stand. References are also given by page number within the text to provide more detailed information for the prescription.

1. Stand site index 70 or greater ..... (p. 3) ...2
1. Stand site index less than 70 .... MANAGE FOR NON-TIMBER RESOURCES (p. 6) DO NOT MANAGE FOR TIMBER
   2. Dominant-codominant trees average 24 inches d.b.h. or more ..... CLEARCUT (p. 3) ...3
   2. Dominant-codominant trees average less than 24 inches d.b.h. 4
3. Source of regeneration for desired species is present .... DO NOTHING, REGENERATION IS EXPECTED ...(p. 3, 5)
3. Regeneration source missing ..... PREPARE SITE AND PLANT ... (p. 5)
   4. Stand contains patches at least 2 acres where dominant-codominant trees average 24 inches d.b.h or more ... PARTITION? ..... (p. 4) ... 5
   4. Stand contains no patches ready for final harvest 6
5. To manage mini-stands ... CLEARCUT PATCHES OF MATURE TREES (p. 3) 3
   TREAT UNCUT AREA AS SECOND STAND ... (p. 4) 6
5. To manage as one stand 6
   6. Stand is fully stocked, exceeds B-line in stocking guide (Appendix) .. THIN TO PRESCRIBED RESIDUAL BASAL AREA ... (p. 4, 10)
   6. Stand is understocked 7
7. Site is suitable for establishing new stand ..... CLEARCUT WHEN MERCHANTABLE (p. 5, 3) 3
7. Site not suitable for new stand ..... MANAGE FOR NON-TIMBER RESOURCES ..... (p. 6)

TIMBER MANAGEMENT CONSIDERATIONS

Elm-ash-cottonwood is confined to river and stream floodplains. Major river stands may be several miles in width, while on smaller streams the stand will be confined to a narrow strip. Managing for timber in narrow stands can severely interfere with other uses of the land by creating erosion problems and eliminating wildlife habitat.

Stand Size

There is no silvicultural reason to restrict maximum stand size though size may be important to consider for esthetics and uses other than timber. However, if natural reproduction is desired a minimum stand size of two acres is recommended. Natural reproduction of most of the desirable bottomland hardwoods (which are shade intolerant) requires full sunlight, so harvesting should provide the forest openings needed for establishing the new stand. Remember that the smaller the opening the greater the amount of its area that is shaded by the surrounding unharvested stand (the "edge effect").

In addition to avoiding excessive edge effect, managers should assure that stands are large enough to warrant mapping and record keeping. Small stands are readily managed and recorded within small forest

holdings but may become a burden on large ownerships. Stands should be relatively uniform in site and vegetation and be easily identified on the ground.

Site Quality

Most E-A-C stands occur on very productive sites—site index 70[1] or more. Sites with an index less than 70 should be considered for uses other than timber.

Determine site index from single-stemmed dominant or codominant trees of the most frequently occurring species on the site. However, when management objectives emphasize particular species, trees of those species should be used.

Height-age measurements should be taken from several trees on each site. Use local site index curves if possible to determine site quality. Otherwise, use the general curves provided for the more common species (Appendix).

Site—Species Relations

Bottomland hardwood sites are complex communities where slight changes in elevation can result in considerable differences in flooding and drainage conditions, soils, and tree species. Of course, the changes are most rapid at right angles to the river rather than parallel to it. Site requirements for common species in the type are summarized below.

Species	Site Requirements[2]
American elm	Common on wet flats and bottomlands throughout the range. Found on soils ranging from coarse sands to clays, but does best on rich, well-drained loams. Seedlings become established on moist litter or mineral soil in partial shade.
Green ash	Common on alluvial soils along rivers and streams throughout the range. Found where good moisture conditions occur in medium-to-coarse textured sands and loams and in clays. Seedlings become established on moist litter or mineral soil in partial shade.
Eastern cottonwood	Common on moist alluvial soil throughout range. Found on soils ranging from coarse sands to clays but makes best growth on fine sandy loam near streams. Seedlings require moist exposed mineral soil and full sunlight for establishment.
Silver maple	Common on alluvial flood plains of major rivers. Found on moist, fine textured silts and clay soils that are imperfectly drained. Seedlings require moist litter or mineral soil and full sunlight for establishment.
Black willow	Common on lower, wetter, less sandy sites along river and stream bottoms throughout range. Pioneer species, intermediate in succession. Found on wide range of soils from sands to clays. Seedlings require very moist exposed mineral soil and full sunlight for establishment.
American sycamore	Sycamore is common on moist alluvial soils along rivers and streams throughout range. Found on wide variety of soils from sands to clays with good moisture supply. Seedlings require moist, exposed mineral soiland full sunlight for development.
River birch	Common on alluvial soils along rivers and streams throughout range. Found on silts and clay soils with imperfect drainage. Seedlings require moist, exposed mineral soil and full sunlight for development.

[1]*Substitute 60 if American elm is used to determine site index.*

[2]*From USDA Forest Service (1965).*

Controlling Stand Harvest

Both the timing and method of stand harvesting affect the timber produced and the new trees established. The timber value and growth rate of the species present and the shade tolerance of the desired reproduction must also be considered (table 1).

Mature Stands

An elm-ash-cottonwood stand is biologically mature and ready for final harvest when dominant-codominant trees average 24 inches in diameter. If the stand is composed primarily of river birch, use 18 inches as the critical diameter; with elm, 20 inches.

Table 1.—*Growth, timber value, and shade tolerance of bottomland hardwood species*[1]

Species	Shade tolerance	Growth rate	Timber value
Green ash	Intolerant	Medium	High
River birch	Intolerant	Low-medium	Low
Cottonwood	Intolerant	Excellent	High
American elm	Intermediate	Medium	Low
Hackberry	Intolerant	Medium	Low
Red maple	Intermediate	Medium	Moderate-low
Silver maple	Intermediate	Medium	Moderate-low
Sweetgum	Intolerant	Medium-good	Moderate
Sycamore	Intolerant	Good-excellent	Moderate
Black willow	Intolerant	Excellent	Moderate

[1]Based on Garrett 1982 and Putnam *et al.* 1960.

Most mature stands will not produce the timber quality and growth that young stands would on the site. Mortality and cull will be increasing. By harvesting the old stand and establishing a new one you can get a higher average annual production and perhaps a better species mix.

A well managed, fully stocked, mature stand will yield from 15,000 to 18,000 board feet per acre (International ¼-inch scale) and 5 to 6 cords of topwood from the harvest cut (table 2).

Clearcut for the final harvest. This not only efficiently removes all products, but creates the opening necessary for establishing a new stand of intolerant species.

Table 2.—*Cumulative yields per acre for well-managed stands on good sites*[1]

Average d.b.h.[2]	Sawtimber		Poletimber	Topwood
	Standing crop	Previous thinnings		
	Board feet[3]		*cords*	*cords*
6	0	0	5.3	0.0
10	0	0	11.8	0.0
14	5,196	0	18.8	6.8
18	10,623	0	18.8	12.7
22	14,699	1,705	18.8	18.2
26	18,243	3,876	18.8	23.2

[1]From Putnam *et al.* 1960.
[2]Average diameter of dominant and codominant trees.
[3]Doyle rule.

Diverse Stands

Even though the whole stand is not mature, portions of it may be ready for final harvest. Delaying the harvest will lead to loss of productivity from mortality and perhaps an excessive decline in quality. Although clearcutting the whole stand would benefit the mature portion, it would sacrifice the young, developing portions of the stand.

This diverse stand, in essence, may be better considered as two stands. A large stand could readily produce two or more stands meeting the stand size criteria, and result in more homogeneous management units.

The newly delineated mature stand should be clearcut. This introduces a different management cycle from the immature stand and will stretch out the timber harvests, while not sacrificing timber production.

Management of the newly delineated immature stand should be for high quality trees.

If a stand is too small to produce two units, you should consider the relative sizes of the mature and immature segments. The amount and condition of other forest holdings should also be considered. This stand, though diverse, should be handled as one. Some sacrifice must be made in timber production to achieve efficient management.

Immature Stands

A fully stocked immature stand (table 3 and stocking guide, Appendix) requires tending throughout its life. Even before trees become merchantable, weeding and thinning will be needed to concentrate growth on the most desirable trees. Trees likely to be culls, slow

Table 3.—*Stocking guide for maintaining good diameter growth on individual well-situated trees on good sites*[1]

Average d.b.h.[2]	A-level[3]	B-level[4]
	No. of trees	
6	475	202
10	202	112
14	112	71
18	71	49
22	49	36
26	36	27

[1]From Putnam *et al.* 1960.
[2]Average diameter of dominant and codominant trees.
[3]Corresponds to A-level, appendix. Beyond this, stand is overstocked.
[4]Corresponds to B-level, appendix. With fewer trees, site isn't fully utilized.

growers, or of little commercial value (see table 1) should be removed unless they are needed to help form the crop trees. If the remaining stand is still too dense, crop trees will need to be removed. The goal is to attain a stand of approximately 50 high quality trees of commercial species per acre at maturity.

Releasing these crop trees through harvest of pole-sized or larger trees of commercial value will yield merchantable timber. This can result in the cumulative yield of 2,000 to 4,000 board feet/acre and 30 to 35 cords of poletimber and topwood from the thinnings before the final harvest (table 2). The recommended stocking of the stand after each thinning should be based on the average stand diameter (table 3 and stocking guide, Appendix). Stands with smaller average diameters should be allowed to grow until they approximate 80 percent of the fully-stocked level; the percent should be gradually reduced as stand diameters increase. Thinning at successive lower stocking levels as stands get older will lead to uniform thinning schedules across all stands regardless of age.

The goal is to maintain a relatively uniform density and diameter distribution throughout the stand as it moves towards maturity. These thinnings through selecting individual trees will produce a relatively homogeneous stand.

Understocked Stands

An understocked stand won't fully utilize the site, i.e., timber production is less than the site's potential. More trees are needed to achieve full productivity. For young stands with sufficient openings to provide the light needed for intolerant species, planting should be considered. Otherwise clearcut when the stand becomes merchantable unless deferring the clearcut would seriously delay bringing the stand to full productivity.

Establishing a new stand is recommended where understocking occurs on otherwise productive sites having the size and access for timber production.

CONTROLLING STAND ESTABLISHMENT

Within one year of harvesting, bottomland hardwood sites produce heavy herbaceous vegetation. Usually, reproduction of desirable trees can come through this cover, and after a few years dense sapling stands will be established. Occasionally, however, shrubs, cane, and vines get established ahead of tree reproduction and become dense enough to exclude trees. For these problem areas you'll have to control this unwanted vegetation, either with herbicides or mechanically.

Controlling Composition

Generally, in the areas to be harvested, advanced reproduction will not be present for all species. However, advanced reproduction may be present for green ash, American elm, and various oak species, including pin oak, shingle oak, and swamp white oak. Past management activities and previous uses will determine the inherited composition. Elm-ash-cottonwood is a subclimax type that, without disturbance, will likely convert to oak or to another type.

With clearcutting, disturbance from logging should expose mineral soil and eliminate competing vegetation. If light and soil moisture are sufficient, natural reproduction from seeds can be expected. Stump sprouts are also a source of reproduction for species in the type, particularly green ash, sweetgum, and sycamore. American elm and hackberry also sprout but to a lesser degree. Harvesting during the dormant season will encourage stump sprouting, provide timely seedbed preparation and should be considered whenever practical.

Preferred species in the type are cottonwood, sycamore, silver maple, and green ash. Willow and river birch are acceptable species for forest products. Elm cannot be expected to realize much commercial value due to Dutch elm disease.

Artificial Regeneration

Consider planting within two years after harvesting if adequate natural regeneration is not present. Planting is expensive because it involves site preparation and maintenance. Select sites carefully; avoid locations that are often flooded.

Clear sites of competing vegetation and debris before planting, as follows:

1. Shear all residual woody vegetation at or near ground level,
2. Pile debris in windrows and burn,[3] and
3. Rake entire surface again to collect any vegetation missed under 2. The planting bed should then be deeply disced and tilled.

The species recommended for planting are cottonwood, green ash, and sycamore, preferably from genetically improved stock. Cottonwood is generally established from cuttings. Green ash and sycamore are generally established from seedlings and attain heights and diameters near that of cottonwood.

Plant seedlings 12 by 12 (feet) as early as possible in the spring. Better survival is achieved with an auger than with a dibble bar. For the first 2 or 3 years, mechanical weeding will be necessary.

[3]*Air quality standards may prohibit burning.*

DAMAGING AGENTS

Flooding

Prolonged flooding during the growing season may kill reproduction and reduce the growth of larger trees. If repeated for 2 or 3 consecutive growing seasons, mature trees will die. Of the species in the association, oaks, sweetgum, river birch, sycamore, and elm are most affected by flooding; ash, cottonwood, and willow, the least.

Flooding during the dormant season is not detrimental to the trees and may even benefit the site. Silt deposited during flooding provides seed beds for germinating cottonwood, willow, sycamore, and other light-seeded species.

Fire

Fire should not be used as a management tool for bottomland hardwoods. All species in this type are very susceptible to fire damage; ground fires readily kill saplings and seedlings and wound larger trees. These wounds, acting as points of entry, facilitate the onset of heartwood decay, which leads to substantial cull and volume loss in bottomland hardwoods.

Following fire, vines and weeds originate and flourish on exposed sites where the trees have been killed. Ground fire destroys organic matter, which causes site deterioration.

Disease

Important diseases in elm-ash-cottonwood are Dutch elm disease, (*Levatocystics celuri*) and heartwood decay. Dutch elm disease has killed most mature elms throughout the type; the remaining ones are primarily in the smaller size classes and few are available for products. Effective control measures have not been developed for Dutch elm disease; all merchantable elm should be removed in any harvesting operation.

Heartwood decay, the major cause of defect and volume loss in the type, generally enters the tree through fire wounds or dead branch stubs. From these points of entry, decay spreads and can destroy the tree. Heartwood decay can largely be controlled by appropriate fire protection.

Insects

Many insects attack the elm-ash-cottonwood type. Elm bark beetles, *Scolytus multistriatus* and *Hylugopinus rutipes*, are insect vectors for Dutch elm disease. Canker worms, *Alsophila pometaria* and *Paleacrita vernata*, and the forest tent caterpillar, *Malacosma udisstria*, major defoliators, and the borers, *Plectrodeva scalator* and *Saperda calvacata*, cause losses in tree growth, survival, and quality.

Trees of low vigor receive the most insect damage. Good forest management practices, e.g., removing damaged, suppressed, and slow growing trees, are the best means for controlling potential damage.

OTHER RESOURCE CONSIDERATIONS

Wildlife

Because elm-ash-cottonwood is located along major water courses and frequently bordered by cropland, it is a primary source of habitat for a variety of wildlife. Wood duck and other waterfowl find nesting areas, food, and shelter here. Also found here are important game species—whitetail deer, ruffed grouse, and gray squirrels; fur bearing amimals—raccoons, beavers, and muskrats; and predators such as red fox, skunk, and others. The type also provides habitat for a variety of songbirds.

Timber harvesting helps provide the diversity of habitat that is desirable for wildlife. Management practices can be modified to meet wildlife requirements. For example, three or four den trees per acre can be left for squirrels and birds. During timber stand improvement, kill some unwanted stems but leave them standing to provide cavities for birds. Leave occasional oak and hickory along with some grapevines, paw paws, and other species, to provide wildlife food.

Water

Elm-ash-cottonwood is important for stream bank stabilization and erosion control. Do not harvest within 50 feet of the stream. Recommended harvests should have little if any effect on water quality or quantity as sites generally will be flat, with slow run off. Water yields may increase slightly following cutting, but will soon return to normal as reproduction is established. Managers of land along streams should be familiar with riparian rights. Each State has its own laws concerning stream maintenance and control.

Recreation and Esthetics

The elm-ash-cottonwood type has great value for dispersed recreation activities. These activities—including hunting, fishing, nature hiking, and bird

watching—are mostly harmonious with timber management. A well managed forest offers a variety of tree sizes and wildlife habitats that contribute to many recreation activities.

The visual impact of timber harvesting can be reduced in several ways. These include leaving islands of standing timber in clearcuts, leaving buffer zones to screen harvesting, having irregularly-shaped harvest zones with only portions visible from one spot, and lopping tops to leave a neat and clean area. Disturbances from logging that expose mineral soil will provide seed beds for natural reproduction; within 3 years, vegetation on the site will obliterate any trace of logging.

APPENDIX

Site Index Curves

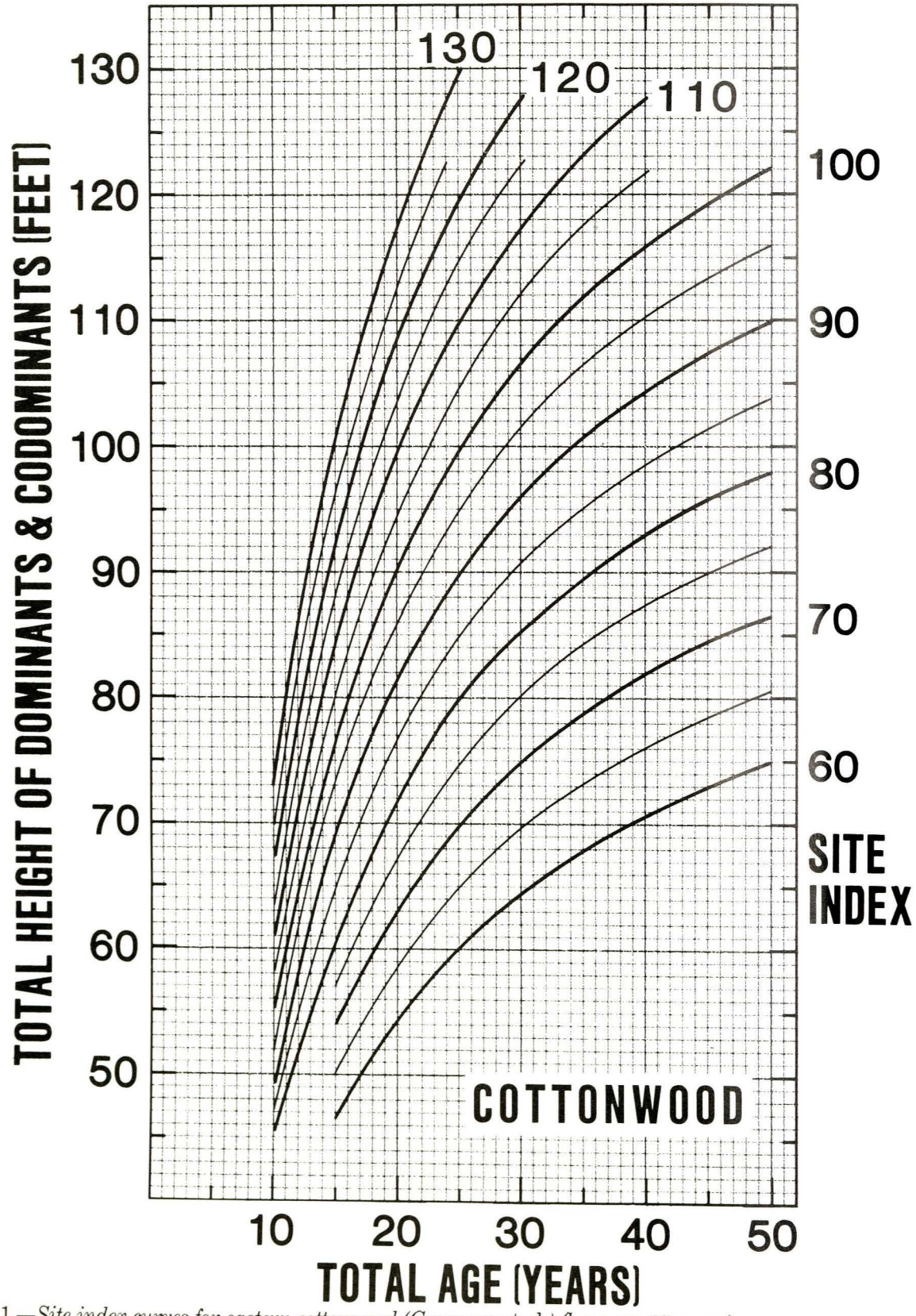


Figure 1.—*Site index curves for eastern cottonwood (Carmean* et al.*) (base age 25 years).*

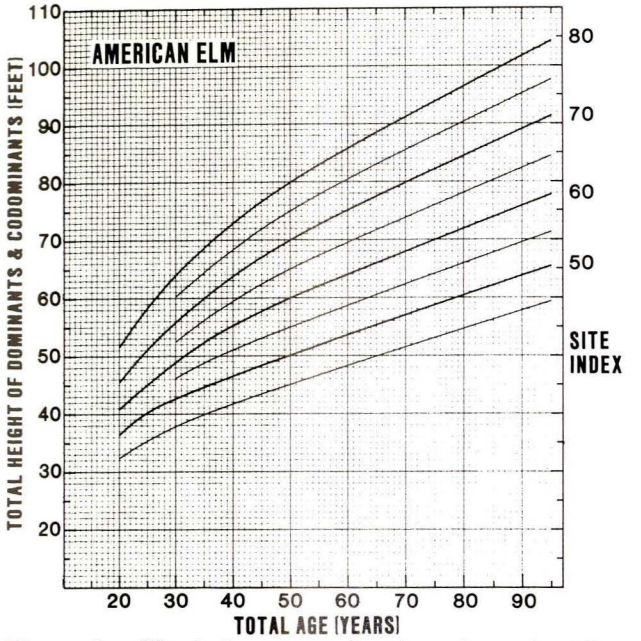


Figure 2.—*Site index curves for American elm (Carmean* et al.*)(base age 50 years).*

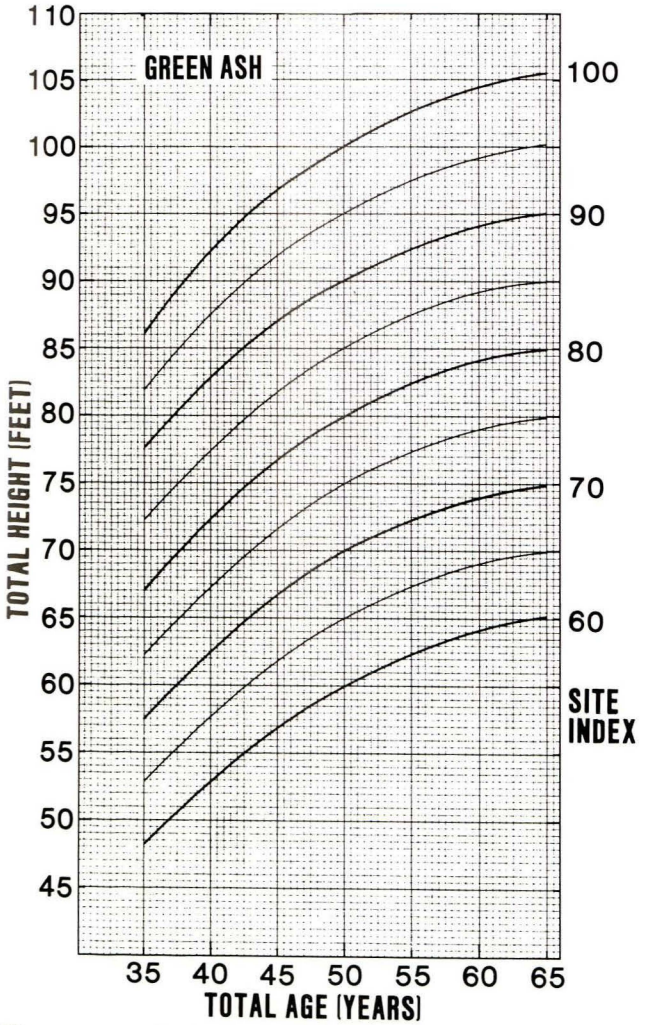


Figure 3.—*Site index curves for green ash (Carmean* et al.*) (base age 50 years).*

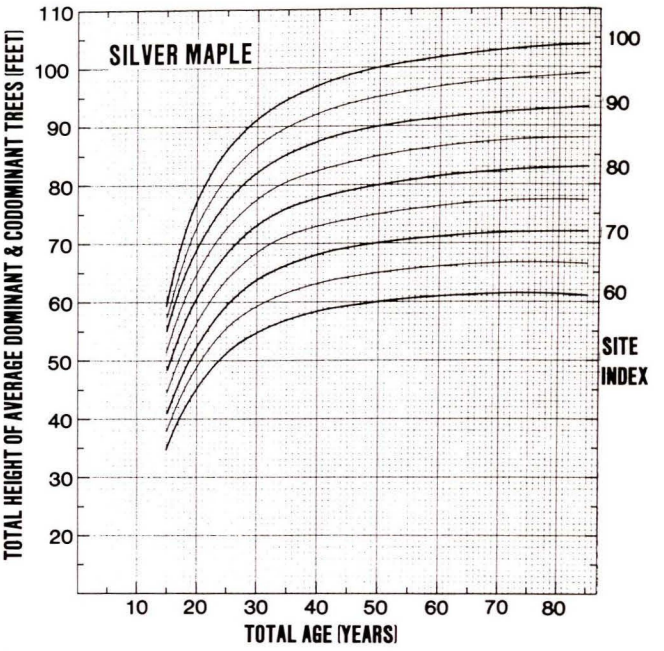


Figure 4.—*Site index curves for silver maple (Carmean* et al.*) (base age 50 years).*

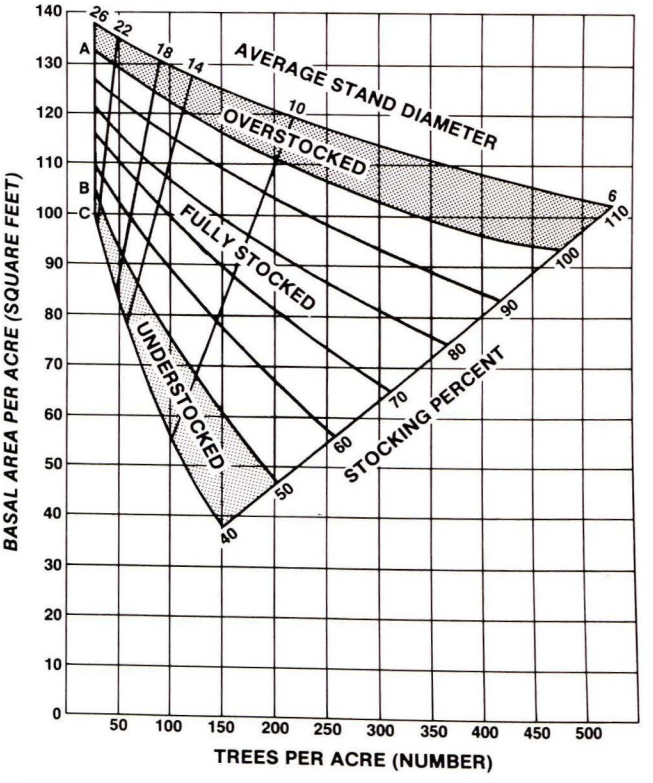


Figure 5.—*Relation of basal area, number of trees, and average tree diameter to stocking percent for elm-ash-cottonwood (based on Putnam* et al. *1960).*

Even-age Stocking Guide

Figure 5 shows the relation of basal area, number of trees, and average stand diameter to stocking percent for elm-ash-cottonwood. The area between curves A and B indicates the range of stocking where trees can fully utilize the site. The curves were developed from Putnam *et al.* 1960.

To use the curves, first inventory the existing stand to determine the number of trees and basal area per acre. Procedures for conducting this inventory are well established but not included here (see Roach 1977). He recommends the use of point sampling to determine basal area per acre and 1/20th-acre plots for number of trees. An example of the use of the graph follows.

Assume a stand contains 100 trees and 130 square feet of basal area per acre. Locating this plot on the graph indicates the stand is over-stocked and has an average tree diameter of 16 inches. From the located point project a line down to the left, parallel to the line of 14 inches average diameter, and note the basal area where the line crosses the B-level stocking.

Deduct B-level stocking (90 square feet) from stand basal area (130 square feet) to arrive at the amount of basal area that can be removed in an intermediate cut (40 square feet). As much as 40 square feet can be removed from the stand without making it understocked.

Metric Conversion Factors

To convert	to	Multiply by
Acres	Hectares	0.405
Board feet[4]	Cubic meters	0.005
Board feet/acre[4]	Cubic meters/hectare	0.012
Chains	Meters	20.117
Cords[4]	Cubic meters	2.605
Cords/acre[4]	Cubicmeters/hectare	6.437
Cubic feet	Cubic meters	0.028
Cubic feet/acre	Cubic meters/hectare	0.070
Degrees Fahrenheit	Degrees Celsius	([5])
Feet	Meters	0.305
Gallons	Liters	3.785
Gallons/acre	Liters/hectare	9.353
Inches	Centimeters	2.540
Miles	Kilometers	1.609
Miles/hour	Meters/second	0.447
Number/acre	Number/hectare	2.471
Ounces	Grams	28.350
Ounces/acre	Grams/hectare	70.053
Pounds	Kilograms	0.454
Pounds/acre	Kilograms/hectare	1.121
Pounds/gallon	Kilograms/liter	0.120
Square feet	Square meters	0.093
Square feet/acre	Square meters/hectare	0.230
Tons	Metric tons	1.102
Tons/acre	Metric tons/hectare	2.242

[4]*The conversion of board feet and cords to cubic meters can only be approximate; the factors are based on an assumed 5.663 board feet (log scale) per cubic foot and a cord with 92 cubic feet of solid material.*

[5]*To convert* °F to °C, use the formula: C°= (F°-32)/1.8.

Common and Scientific Names of Plants and Animals

Plants

Ash, green ..... *Fraxinus pennsylvanica*
Birch, river ..... *Betula nigra*
Cottonwood, eastern ..... *Populus deltoides*
Elm, American ..... *Ulmus americana*
Grape ..... *Vitis* spp.
Hickory ..... *Carya* spp.
Maple, silver ..... *Acer saccharinum*
Oak, pin ..... *Quercus palustris*
Oak, shingle ..... *Quercus imbricaria*
Oak, swamp white ..... *Quercus bicolor*
Oak, white ..... *Quercus alba*
Paw paw ..... *Asimina triloba*
Sycamore ..... *Platanus occidentalis*
Willow, black ..... *Salix nigra*

Animals

Beaver ..... *Castor canadensis*
Deer, whitetailed ..... *Odocoileus virginianus*
Duck, wood ..... *Aix sponsa*
Fox, red ..... *Vulpes vulpes*
Grouse, ruffed ..... *Bonasa umbellus*
Muskrat ..... *Ondatra zibethica*
Racoon ..... *Procyon lotor*
Skunk ..... *Mephitis* spp.
Squirrel, gray ..... *Sciurus carolinensis*

REFERENCES

Barrett, John W., ed. Regional silviculture of the United States, 2d ed. New York: John Wiley & Sons; 1980. 551 p.

Bell, David T. Tree stratum composition and distribution in the streamside forest. Am. Midl. Nat. 92(1): 35-46; 1974.

Carmean, Willard H.; Jacobs, Rodney D.; Hahn, Jerold T. Site index curves for eastern U.S. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. [in preparation].

Fitzgerald, Charles H.; Belanger, Roger P.; Lester, William W. Characteristics and growth of natural green ash stands. J. For. 73: 486-488; 1975.

Garrett, H. E. Natural regeneration of bottomland hardwoods in the Upper Mississippi River Valley. In: Proceedings, Hardwood Regeneration Conference; 1982 March 2-3; Winona, MN. St. Paul, MN: University of Minnesota, Agricultural Extension Service; 1982: 42-54.

Hosner, John F.; Minckler, L. S. Hardwood reproduction in the river bottoms of southern Illinois. For. Sci. 6: 67-77; 1960.

Hosner, John F.; Minckler, Leon S. Bottomland hardwood forests of southern Illinois-regeneration and succession. Ecology 44(1): 29-41; 1963.

Illinois Technical Forest Associates. Recommended silviculture and management practices. Illinois Hardwood For. Types; 1965. 46 p.

Johnson, Robert L. Natural regeneration and development of nuttall oak and associated species. Res. Pap. SO-104. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1975. 12 p.

Krajicek, John E.; Minckler, Leon S. Volume and growth for Pottsville mixed bottomland hardwood plots after seven growing seasons; 1953-1960. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1961. 17 p. (Unpublished report)

Lindsey, Alton A.; Petty, Robert O.; Sterling, David K.; VanAsdall, Willard. Vegetation and environment along the Wabash and Tippecanoe Rivers. Ecol. Monogr. 31: 105-156; 1961.

Minckler, Leon S. Bottomland hardwoods respond to cutting. CS Tech. Pap. 154. Columbus, OH: U.S. Department of Agriculture, Forest Service; 1958. 10 p.

Putnam, John A. Cutting schedule for even-aged bottomland hardwoods. J. For. 50(11): 866-867; 1952.

Putnam, John A.; Furnival, G. M.; McKnight, J. S. Management and inventory of southern hardwoods. Agric. Handb. 181. Washington, DC: U.S. Department of Agriculture; 1960. 102 p.

Roach, Benjamin A. A stocking guide for allegheny hardwoods and its use in controlling intermediate cuts. Res. Pap. NE-373. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1977. 30 p.

Shifley, Stephen R.; Brown, Kenneth M. Elm-ash-cottonwood forest type bibliography. Gen. Tech. Rep. NC-42. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1978. 56 p.

PESTICIDE PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

Note: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency consult your county agriculture agent or State extension specialist to be sure the intended use is still registered.

☆ U. S. Government Printing Office: 1984 - 767 - 143/10059

Myers, Charles C.; Buchman, Roland G.
Managers handbook for elm-ash-cottonwood in the North Central States. Gen. Tech. Rep. NC-98. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1984. 11 p.

Presents the resource manager with a key for choosing silvicultural practices for the elm-ash-cottonwood type in the North Central States. Timber production is emphasized.

KEY WORDS: Forest management, regeneration, management guide, bottom-land hardwoods, timber production.